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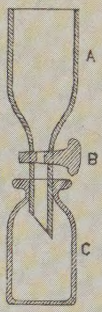
Fig. 1.

Fig. 7.



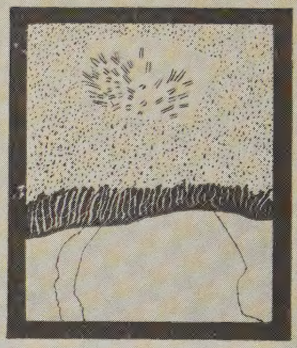


Fig. 2.

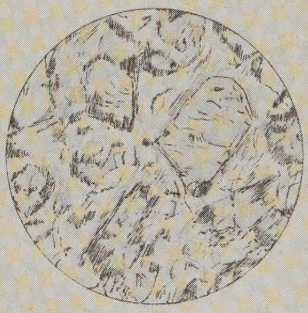


Fig. 3.

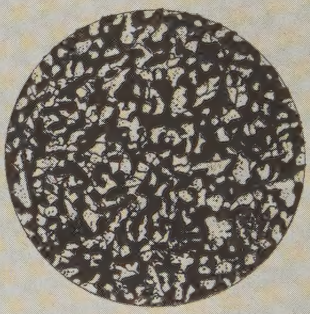


Fig. 4.

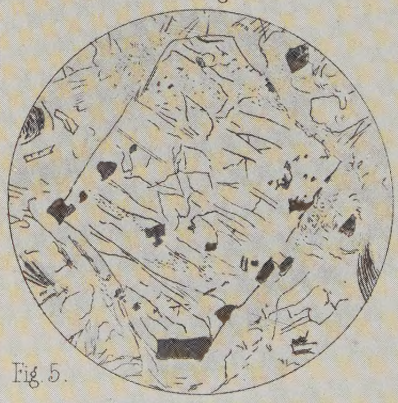


Fig. 5.

Fig. 6.

Copied from original partly coloured plates.

Books Received.

From *Royal Society of New South Wales, Sydney.* Rules and List of Members.
" " List of exchanges and presentations.
" *Prof. Jas. D. Dana, Newhaven.* American Journal of Science, Sep. to Nov. 1877.
" *Prof. How, Nova Scotia.* Report of the Department of Mines, No. 8.
" *Prof. Groth.* Zeitschrift für Krystallographie und Mineralogie. Heft 6.
" *Reale Comitato Geologico d'Italia.* Bollettino, 7 to 10.
" *T. A. Readwin, Liverpool.* Beiträge Zur Kenntniss des Turnerit, by Dr. Chas. O. Trechmann.
" *G. Spezia, Turin.* Sul Berillo del protogine del monte Bianco.
" " Sul colore del Zircone.
" " Intorno ad un calcifero della zona delle pietre verdi.

Publications Exchanged.

The Mineralogical Society of Great Britain and Ireland exchanges publications with the following Institutions and Magazines.

Royal Society of New South Wales, *Sydney.*

Reale Comitato Geologico d'Italia, *Rome.*

Zeitschrift für Krystallographie und Mineralogie, *Strasburg*, per Prof. Groth.

American Journal of Science, *Newhaven.* per Prof. Jas. D. Dana.

Department of Mines, *Nova Scotia,* per Prof. How.

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MINERALOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND.

No. 7. NOVEMBER, 1877. Vol. 1.

I.—*On the Microscopic Structure of Luxullianite.*—By T. G. Bonney, M.A., F.G.S., Fellow and late Tutor of St. John's College, Cambridge.

So far as I am aware no account of the microscopic structure of this rare and beautiful rock has yet been published. I have, therefore, thought that a brief description of its structure and some considerations concerning the origin of tourmaline rocks may be of interest to petrologists.

Boulders of the rock, as is well known, are abundant in the vicinity of the village of Luxullian (about five miles from the town of St. Austell, Cornwall), where I collected specimens in the autumn of 1873; but I believe the rock itself has never been discovered *in situ*, though veins of different varieties of tourmaline rock are abundant in the granite of this and other districts in Cornwall, some of which occasionally rather resemble it, and the mineral frequently occurs in the granite itself, the felsite elvans, and the altered sedimentary rocks.

Luxullianite* consists of a groundmass of velvet black tourmaline (schorl), in which are embedded grains of whitish quartz, occasional small rather irregular crystals of felspar, and a number of larger and

* It will not be forgotten that a magnificent block of this rock is used for the sarcophagus of the late Duke of Wellington.

more regular crystals of the same mineral, commonly from one to two inches in length. These are evidently orthoclase, of a light-pinkish-red colour, spotted with small included crystals of schorl. On a closer examination of the ground mass, it is seen to be composed of a dense mass of minute acicular crystals of schorl, matted together like intergrowing tufts of grass, and interspersed with white quartz. The exterior of the boulders has a rather slaggy aspect. This is caused by the schorl decomposing more slowly than the felspar, and so projecting with an irregular rough surface. When the schorl decomposes it assumes a dull greenish or sometimes brownish hue. The rock is extremely tough except when decomposed, and it is thus very difficult to obtain good specimens. The slide which I am about to describe was cut for me by Mr. Cuttell from a specimen not collected by myself, but selected for that purpose because of its excellent state of preservation—I am informed that it is generally a difficult rock to prepare for the microscope.

On examining the slide by transmitted light, the rock is found to consist of a groundmass of colourless quartz, often crowded with acicular crystals of schorl,* of irregular grains of brownish tourmaline, and of crystals of orthoclase felspar. more or less decomposed. I shall describe these as far as possible separately.

The groundmass.—The quartz is generally clear and pellucid, but here and there it contains minute endomorphs. These in some cases appear to be very minute belonites, which are probably schorl, but often they seem amorphous brownish grains, just like a fine dust. The schorl occurs in acicular crystals, which are massed together in tufts; the needle-like crystals radiating from a centre, like blades of grass from a root (see fig. 1 Plate VII). In places, the more minute crystals have so intergrown as to render the slide almost opaque; but when they attain a somewhat larger size and are less crowded, the effect is singularly beautiful. The crystals, so far as I can ascertain, are hexagonal prisms tapering towards the free end; they are often about 0·03 inch long, and 0·001 inch in diameter. The crystals when cut across the prism are of a translucent indigo blue or dull greenish blue colour, when cut length-wise rather of a greenish

* For brevity I will employ this name to designate the bluish variety. This would be a more distinct black when thick than the other, which inclines to yellowish brown. As will be seen hereafter, I suspect there is a difference in the chemical composition of the two kinds.

drab or pale brownish stone colour.* As they are intersected in all directions, there are of course endless varieties of tint. With polarized light the longitudinal sections exhibit strong dichroism, changing from the above brownish to bluish green tints as the polarizer is moved through 90° : with crossed prisms the same sections exhibit great varieties of colour, from pale golden-yellow to green and pinkish-purple, changing beautifully as the polarizer is rotated. It is now seen that the quartz in which these crystals are imbedded—seemingly growing in it like herbs under water—is not only crystalline, but consists of various granules, rendered very distinct by the different colours which they assume. Yet the schorl crystals are in no way limited by the surfaces of these, but pass indifferently from granule to granule. They are, however, either arrested abruptly at the edge of one of the felspar crystals, or only penetrate it to a very slight distance.

The Brown Tourmaline.—Leaving the groundmass awhile, I pass on to this constituent. With transmitted light it is seen to form grains of irregular outline (generally considerably longer than wide, with the longer exterior boundary occasionally rectilinear, or nearly so), and of a pale golden-brown colour (see fig. 2 Plate VII). They are traversed by irregular cracks, which occasionally give indications of a very imperfect cleavage parallel to the longer sides. Minute microliths and cavities—not generally numerous—appears also not seldom to have a similar arrangement. The grains included on the present slide vary from about 0·02 to 0·2 inch in the longer diameter. With polarized light the dichroism of all is shewn to be much less strong than that of the schorl crystals. When the light is analysed the colours are not generally rich (except in the case of one grain). No trace is seen of aggregate polarization. Each grain, however, is bordered by a dense mat of schorl crystals; sometimes these are short and crowded so a simply to form a comparatively thick opaque line (fig. 2), but generally they are of the usual shape, and sprout from the edges of the larger crystals like tufts of moss growing on a stone. This comparison is justified by the fact that minute dust-like microliths and ferruginous brown veinings abound where the belonites are most most closely matted, so that the blades appear to grow from a kind of soil supported by the larger tourmaline crystal.

* We have not attempted to represent this dichroism in the figure.

The porphyritic crystals of orthoclase.—When examined microscopically these are seen to be much decomposed, being more or less clouded with a fine brown dust, and containing numerous schorl microliths, which are occasionally gathered into small tufts. With polarized and analysed light they exhibit no brilliant colours, but a dull aspect, sometimes almost opaque, sometimes rather mottled with milky white; in short, the ordinary appearance of felspars which have been affected by water. The tufts of schorl belonites, however, are almost invariably implanted in a small area of clear quartz (fig. 1) generally as nearly as possible conterminous with the ends of the schorl needles; and whenever the latter appear to have penetrated from without into the surface of the felspar crystal, the accompanying interstitial quartz seems to encroach upon and pierce into the generally linear edge of the crystal.

This microscopic study of the rock would leads us to the conclusion that the microlithic schorl results from chemical action on felspar; and I think we may regard the Luxullianite as a peculiar metamorphic form of the normal granite of the country. It is well known that tourmaline is frequently present in granite and felsites, especially in Cornwall. I have studied several of these both microscopically and in the field; and the mineral has always had the aspect of a secondary product, and seemed to be closely associated with decomposed felspar. For instance, I may refer to the veins of schorl rock so common in South-western Cornwall, which may be traced through decomposing granite till they die away in strings. From these veins we may collect specimens in every stage, from what we should call a rather decomposed granite rich in schorl to a rock which seems to consist solely of quartz and schorl. I may refer also to apparent dykes of schorl rock, or very schorlaceous granite, which I have seen W. of Mousehole; these at first sight might be taken for true intrusive dykes, but on closer examination are seen to pass, though rapidly, into the adjoining rock; as well as to the sections to be seen near the Carclaze Mine (St. Austell), where veins and nodes of schorl abound in the granite near its junction with the "killas," and the latter rock is now composed of alternating sandy and schorlaceous layers. I think no one can study this district without coming to the conclusion that the schorl is a secondary product formed from the felspathic constituents of the various rocks.

If, however, Luxullianite is an altered granite, two difficulties must be considered. The Cornish granite consists of mica, felspar,

and quartz. How then do we account for (*a*) the absence of the first mineral; and (*b*) the fact that the original grains of the last (if such existed), do not seem to have offered any opposition to the formation of the schorl crystals?

(*a*). It will have been observed already that I have spoken of two varieties of tourmaline in luxullianite which differ markedly one from another; one, the brown variety, found always in grains, which (omitting some filmy specks occurring here and there among the denser part of the other kind) are of considerable size and irregular form—the other always acicular, more or less aggregated, of a bluish colour, and (as I think) more strongly dichroic. In examining the first I am struck by the general resemblance which the grains present to the ordinary forms of mica, and by the indications of cleavage already mentioned, which much more resemble that of the black mica occurring so commonly in the Cornish granites, than the very irregular structure of tourmaline. Its mode of occurrence seems to indicate that it is not a true cleavage of the tourmaline itself, but a kind of pseudomorphic structure. I have also noticed in examining other rocks containing tourmaline that mica does not occur where it abounds, and that where the two are found together, the former appears to replace to some extent the latter.

A section from a specimen of granite collected in the quarry near the railway viaduct W. of S. Austell, gives, I think, full proof of this. The rock itself shews a fair proportion of schorl occurring much as the black mica (probably biotite) ordinarily does, and some silvery-white mica (? margarodite). Examined by transmitted light, it will be seen that much of the tourmaline (which is brown in colour) presents a resemblance to the ordinary form of mica, preserves distinct traces of the characteristic basal cleavage of that mineral, while here and there are remnants of mica not wholly altered. In some cases the bluish variety (which I have called schorl) also is seen bordering the changed biotite crystal, but here appearing to be developed from it: it is not, however, abundant, and has not the tufted arrangement.* The felspar is a good deal decomposed, but only shews occasional microliths of both varieties of tourmaline.†

* In another slide from the Mousehole rock the schorl generally borders the brown tourmaline where it is contiguous to felspar crystals.

† I am aware that the opinions above expressed differ from those of Dr. Senft (*Die Krystallinische Felsengemengtheile, &c.*, p. 505), who regards mica as an alteration product of tourmaline, and gives a section which appears to favour his

(*b*). The acicular schorl passes from grain to grain of the quartz. On any hypothesis this seems rather strange, but on that of the former mineral being a secondary product it is very perplexing. It would be a most exceptional thing for a slice of average Cornish granite nearly $\frac{3}{4}$ inch in diameter not to contain some free quartz; and if this one did so contain it, how are we to explain its easy penetration by the schorl. There is one small grain evidently not a secondary product, free from schorl, but this, it is important to note, is completely enclosed in one of the larger crystals of felspar. Hence, I conclude that the more probable hypothesis is that the chemical agents which produced the schorl rendered the quartz sufficiently plastic to yield easily to the crystalline forces.* Hydrofluoric acid will gelatinize quartz, and we must not forget that fluorine is generally present in tourmaline.

The very variable composition of the latter mineral would lead us to anticipate that it would, under certain circumstances, be present as a decomposition product of more than one mineral, and its presence as above described seems to accord with our expectations. We observe on consulting a table of analyses of tourmaline, such as is given by Dana (Mineralogy, p. 368), that magnesia is generally present, sometimes in large amounts (up to 14·89 per cent). According to De la Beche (Geology of Cornwall, p. 189) a tourmaline from Bovey, which he takes as also representing the Cornish mineral, contained 0·70 per cent. For these reasons, if we had supposed it formed from felspar alone, we should have had to consider our mineral to be a variety exceptionally poor in magnesia, and it would also have been asked what had become of the biotite, so normal a constituent of the Cornish granite. Senft, however (*op. cit.* p. 507), shews the possibility of the change of tourmaline into magnesia mica; and as it appears to me his reasoning will not only

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view. Not having seen the locality, I cannot say whether his interpretation is the only one possible; and at any rate it leaves quite unanswered the difficulty of what fluid formed the tourmaline rock from either granite or quartz (the rock adjoining the veins); we must also remember that the order of chemical change in nature not seldom differs. Be this, however, as it may, I have carefully considered the question and can put no other interpretation than the above on the microscopic sections which I am now describing.

* In like way I have seen acicular crystals of secondary actinolite pierce into crystals of comparatively undecomposed felspar. This is described in a paper presented last May to the Geological Society, but not yet published.

bear reversal, but be simplified by it* (for Lithium, Boron, and Fluorine are the constituents which we should expect to be added by the agency of water), so that we need not further discuss this. Again, the formation from felspar of a tourmaline poor in magnesia by the addition of the required constituents is quite possible, as an inspection of tables of analyses will shew, by the loss of alkali, addition of iron protoxide boracic, lithic, and fluoric acid, and the disengagement of the superfluous silica. Of this last, there will obviously be a large quantity. Taking for purposes of rough calculation, the analysis given by De la Beche (*loc cit.*) $SiO_2=35{\cdot}20$, $Al_2O_3=35{\cdot}50$ in tourmaline; and that given by Nicol (Mineralogy, p. 110) for orthoclase, $SiO_2=64{\cdot}6$, $Al_2O_3=18{\cdot}5$; we shall see that in forming the former mineral from the latter (supposing the Al_2O_3 unchanged in quantity) we require very nearly 18·1 parts of the SiO_2 in the orthoclase, and so liberate about $\frac{31}{43}$ (nearly 0·72 of the whole). This then fully explains the abundance of quartz in the Luxullianite and its association with the schorl needles.

The remarkably interesting case described by Mr. Collins (p. 115), where there is considerable resemblance between the crystals figured by him and those described by me, must not be overlooked, as it points at first sight to a simultaneous formation of the quartz and tourmaline. As, however, the quartz crystal was found in a cavity in schorlaceous granite, there is no reason why its constituents should not have been dissolved from the granite by water as above.

I think then that the study of this and the other above described varieties of tourmaline bearing rocks, both in the field and microscopically, justify us in regarding them as the result of the action of water, containing the requisite substances in solution, and probably at rather a high temperature, upon granite, felsite, and certain sedimentary rocks.†

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* It must also be remembered that water is a constituent of tourmaline, which favours the idea of its being a secondary product.

† Sir H. De la Beche op: cit. p. 160, regards the schorl as, at any rate in many cases, a secondary product, though he does not appear to have considered the details of the question. Since the above was written my attention has been called to a notice in the Comptes Rendus for 1864, by M. Pisani (p. 913). He regards Luxullianite as an altered granite and states that tourmaline has replaced the mica; the opinion, however, seems to be a conjecture formed on a general examination without the microscope, as the rock is said to contain very little quartz, which is hardly correct.

II.—*Note on the Serpentine of Duporth, in St. Austell Bay, Cornwall.*—By J. H. Collins, F.G.S.

THE Geological Survey Map of Cornwall shews, to the south of the town of St. Austell, several patches of "greenstone," extending from near the ancient earthwork called Trethullan Castle, on the west, to the sea at St. Austell Bay in the east; a distance of over four miles.

The western end of the most extensive of these patches swells ont on the top of the hill to the north-east of St. Mewan Church, so as to cover several hundred acres (including some of the best land in the parish). This was described by Mr. J. Arthur Phillips some years since in the Philosophical Magazine.* Mr. Phillips speaks of the rock as being distinctly crystalline, consisting of felspar (sometimes triclinic); semi-transparent yellowish-brown crystals, probably hornblende; a green fibrous mineral also believed to be a variety of hornblende; many black grains of oxide of iron and a few hexagonal crystals, probably apatite; and he says the rock exhibits unmistakeable evidence of extensive alteration. Speaking of its extension eastward, he says "it extends in diminished proportions in a southeasterly direction to the sea at Duporth."

An examination of this intrusive mass in different parts of its course, shews that it becomes more coarsely crystalline and porphyritic as it approaches the cliffs, and that the chemical composition is also changed, until, finally, the hornblendic rock of St. Mewan becomes a serpentine at Duporth.

The clay-slate in the cliffs is soft and yellowish, and dips about 20°, to the W. N. W. Apparently interbedded with this is the serpentine, in a mass from 40 to 50 feet thick, of a general greenish-grey color, mostly soft, often somewhat schistose, and considerably decomposed near the surface.

* Phil. Mag. Feb., 1871.

The less decomposed portions near the sea-level are seen to consist of serpentine of a darker green colour, full of grayish-white spots of a substance resembling kaolin, which on examination appear to be pseudomorphs of hornblende and perhaps felspar, varying from 1-20 to 1-4th of an inch in length. The crystals have not quite lost their power of depolarizing polarized light, but the difference between the crystals and the green base in this respect, is not extremely great.

The green serpentine base is often somewhat fibrous, the fibres curving round the larger crystals and exhibiting brilliant colours with polarized light; it is sprinkled with very small prisms of scarcely altered felspar. The base and the altered included crystals are both sprinkled pretty thickly with crystals and grains of oxide of iron, and the whole rock is in places stained yellow or brown with peroxide of iron.

Fig. 3 Plate VII shews the appearance of a polished specimen unmagnified; fig 4 a rather thick section magnified twelve diameters. Fig. 5 illustrates the internal structure of one of the large altered hornblende crystals, and fig. 6 the characters of the serpentine part magnified 200 diameters.

Proceeding inland, the rock soon becomes harder, but is still full of imbedded crystals, mostly of hornblende with some felspar, until at St. Mewan it is so fine-grained that the ingredients mentioned by Mr. J. A. Phillips can rarely be distinguished without using a lens. I have spoken of the serpentine as being *apparently* interbedded with the killas at Duporth. This is how it appears at that place, but at Gewans, about a mile inland, where the rock is very hard, and is extensively wrought for road stone, it distinctly cuts through the slates and appears as a great east and west dyke at least 60 feet wide and nearly perpendicular, the killas there dipping to the N.W. It is also distinctly intrusive at St. Mewan, as pointed out by Mr. Phillips.

The following analyses shew the interesting changes of chemical composition exhibited in this mass in different parts of its course. (*a*) is the mean of three analyses of the rock at St. Mewan made by Mr. Phillips,* (*b*) is my own analysis of the rock from the quarry

* Phil. Mag., Feb., 1871.

near Gewans, (*c*) my analysis of the rock at Duporth, and (*d*) a recent analysis of the same rock made by Mr. J. Arthur Phillips.†

	a.	*b.*	*c.*	*d.*
Sp. Gr.	2·97	2·86	2·64	2·86
Water	·80‡	·80§	8·65‖	·72 9·29
Silica	47·57	50·24	37·09	35·74
Titanic acid	trace	trace	trace	——
Phosphoric acid ..	·12	·20	·21	·18
Alumina	17·16	19·19	19.90	12·23
Ferric oxide ..	13·04	15·30	15·54	4·68
Ferrous oxide ..	9·30		2·02	13·84
Oxide of manganese,	trace	trace	trace	·98
Sulphur	trace	trace	——	——
Lime	4·11	5·02	trace	trace
Magnesia	trace	·93	15·90	22·13
Potash	2·30	7·21	trace	trace
Soda	5·45			·25
	99·85	98·89	99·31	100·04

From these analyses it appears that the change is not great at Gewans as compared with St. Mewan, a distance of a mile and a half, and that it consists chiefly in a lessening of the proportions of iron oxides and a slight increase in the silica. Within the next mile, however, a very notable change takes place, the silica being reduced by upwards of 12 per cent. and the alkalies entirely carried off, while the proportion of water increases from less than 1 to over 8 per cent, and the magnesia from less than 1 to nearly 16 per cent. or in Mr. Phillips's specimen over 22 per cent. Chemically and mineralogically the rock now consists essentially of a base something over 30 per cent. of serpentine, containing in crystals and grains, nearly 50 per cent. of kaolin, and nearly 20 per cent. of peroxide and magnetic oxide of iron.

†For this analysis I am indebted to Mr. Phillips, who has courteously sent me his results since the reading of the above paper. He remarks "I find more magnesia than you do, but my specimens have undergone more extensive change than yours, as you will see from the fragment which I enclose." He also observes "My recent analysis of some remarkably fresh rock from the Sanctuaries gave 1·75 per cent. of magnesia.

‡ ·33 lost in water bath. § ·5 lost at 120° C. ‖ 2·73 lost at 120° C.

As to the cause of this remarkable change of a hornblendic into a serpentinous rock, there is little at present to guide us; but the district is one of very extensive disturbance, traversed in all directions by mineral lodes and elvan courses; and it is not more than 2 miles from the St. Austell granite. I have, in a paper read before the Royal Geological Society of Cornwall in 1876, given my reasons in detail for believing that the extensive alteration of the felspar of that granite into kaolin has been produced by mineral solutions acting through fissures from below, and I have little doubt that this production of serpentine is due to a similar action, but the proof of this speculation is, I think, still wanting. If I were to guess, I should say fluoride of magnesia was the principal cause of the alteration.

III.—*Note on Duporthite, a new Asbestiform Mineral.*—By J. H. Collins, F.G.S.

THIS mineral occurs in fibrous masses occupying fissures or shrinkage cracks in the serpentine of Duporth, near St. Austell, Cornwall. The thickest veins I have seen are not more than $1\frac{1}{2}$ inches. The fibres are placed transversely across the vein, making generally an angle with the walls of about 70°, so that the crystallization is probably oblique.

The mineral is greenish to brownish gray, has a silky lustre, H about 2 and Sp. Gr. 2·78 : insoluble in HCl, but the iron and magnesia are slowly dissolved out.

Thin fibres are flexible like asbestos. Heated in a matrass the mineral gives off a little water, and becomes lighter coloured; in forceps thin fibres fuse to a dark glass in the hottest part of the flame. The spectroscope shews the sodium and calcium lines distinctly, but no trace of potassium or lithium.

The following is the analysis :—

	EXP.	THEORY.
Silica	49·21	48·0
Alumina	27·26	30·9
Protoxide of iron ..	6·20	7·2
Magnesia	11·14	12·0
Lime	·39	
Soda	·49	
Water	3·90	1·8
Do. *hygros.*	·68	
	99·27	

About half of the water is given off more readily than the other half. If we regard the more obstinate portion of the water as basic, this composition agrees tolerably well with the formula $3\ (Al_2O_3\ Si\ O_2) + 5\ (\frac{3}{5}\ Mg., \frac{1}{5}\ Fe., \frac{1}{5}\ H)_2\ O\ Si\ O_2$. It has some resemblance to chrysotile, anthophyllite, and some of the fibrous hornblendes, but differs widely from them in composition. The mineral which comes

nearest to it in appearance as well as composition in Danas *Neolite** from Arendat and Eisanach, but this contains more than twice as much magnesia and less than half the alumina. As I cannot find any mineral whose composition at all approaches it, I propose to call it *Duporthite* from the locality—Duporth—in which I discovered it. I have little doubt that much of the so-called chrysotile or fibrous serpentine is really aluminous, and analagous to this mineral.

* System, p. 406.

IV.—*Further Notes on Mineral "growth."*—By T. A. Readwin, F.G.S., &c.

ABSTRACT.

MR. READWIN stated that since reading his former paper (Min. Mag., No. 5), he had visited the museums of Copenhagen, Stockholm, Christiania, Kongsberg, and London, in search of corroborative evidences of "Recent Mineral-growth at ordinary temperatures, under ordinary conditions," and that he was satisfied that mineral "growth under ordinary conditions," is not of unusual occurrence, although, hitherto, neither generally observed, nor believed.

Mr. Readwin also stated that several of the specimens referred to in his former paper, some of which he took on his journey, exhibited changes and developments during his absence.

In conclusion, Mr. Readwin submitted an idea of Metal-growth more closely at home.

Every shaving-man he said, knows by experience, that sometimes after long stropping in the same direction, his razors provokingly "*get tired of shaving*," and, that, after *sufficient rest*, they frequently "*recover their edge.*"

That the edge-particles *do* re-arrange themselves, at times, the microscope has often revealed. Indeed I may say my own chin has often proved it to me, and that I feel half-tempted to speak of the change as "Steel-growth." [July 7.]

[Memorandum, Aug. 10] Early in 1871 I reduced the *size* of a good many of my Merionethshire auriferous minerals, and after taking great care to preserve every bit of quartz, &c., that "showed a speck of gold," I put the refuse fragments, &c. into a large box, nailed it down securely, without any definite object; and forgot it entirely. *Yesterday* my eye happened to rest upon it, and I spent nearly the whole day in the careful examination of its contents. I was more than repaid for my trouble by finding 62 quartz and pyrites specimens having upon them appreciable electrum-growth; three of which, present, are particularly interesting. I mark them X, Y, Z; in X is an unusual growth mode. On Y, near label, is is another. Z has a growth somewhat similar, and recommends itself, also, as to recent quartz-crystallization.

V.—*Notes on some Norwegian Minerals.*—By T. A. Readwin, F.G.S., &c.

THE Silver-mines, near Kongsberg, in Norway, are said to have been worked unceasingly for the last 200 years or more.

On June 6th, last, I was fortunate in being allowed to visit these celebrated mines, and also the silver-works at Kongsberg. More fortunate still, in obtaining the present beautiful specimens* of native silver and Argentite. They had very recently been taken from the mines, and I was told that my visit was opportune, because such specimens were not of every day occurrence. Be this, as it may, they are of especial interest just now, as illustrating the theory of "metal-growth," and the more particularly so, as two of them have most obligingly, since they came into my possession, thrown out sundry hints of bodily activity. In fact, have "grown"; and, as they have a direct bearing upon a previous paper, I propose to describe them as well as I can.†

Here are nine specimens, marked 2, 6, 10, 11, 13, 14, 18, 94, and 123.

Specimen 13 is silver-sulphide (Argentite), embedded in, and projecting from pure white calcite, which is built up chiefly of fundamental rhombohedrons of vitreous lustre and easy cleavage. A portion of the calcite is massive, and without lustre.

Upon the surface of the Calcite are numerous small specks of fantastically-shaped argentite, from two of which (*a* and *b*), silver has begun to extrude, or grow.

A pervading internal gray color, seen through portions of the calcite, may indicate some latent argentite in the specimen.

* These specimens were sent to the meeting at Plymouth for examination, but did not arrive in time.

† The descriptions are mostly unintelligible without the specimens, they have therefore been abridged.

The projecting argentite ($1\frac{1}{2} \times \frac{1}{2} \times \frac{3}{4}$ inch), it is difficult to describe. It is nearly covered with a thin, opaque, asbestos-like, milk-white film, which very easily peels off. This film, or overcoating will not effervesce with the acids. It is colored yellow thereby, but is not destroyed.*

The *chief* mass of argentite is a bundle of inter-lacing, intercurling, and conjoining exudations, more or less recent; and none of them, perhaps, of remote origin.

In places, where the coating has been removed, the argentite is of a brilliant gray metallic lustre, and is, for the most part, amorphous.

A small "growth," *only a month old* (near index f), is *singularly pendulous*, and is extremely sensitive to the slightest *vertical* movement of the specimen. [Mem., 7 July]. [Mem., Oct. 26]. The pendulous extrusion has since grown off.

Two small silver-exudations have since appeared out of the film-covered argentite, as well as several very delicate purely argentite growths in the cavities. [Mem., 7 Aug.]

Specimen 10 is Argentite in pure white Calcite. This specimen exhibits no fundamental rhombohedral form of calcite; but there are several small hexagonal prisms in one cavity, and exquisite modified scalene dodecahedral forms in another.

The prominent amorphous mass of thi isnteresting sulphide ($\frac{3}{4} + \frac{1}{2} + \frac{3}{4}$ inch) was completely covered with the opaque white coating, until I peeled off a portion of it, to test with acids, and left it of a brightly-shining gray color, without any appearance of growth.

No perceptible alteration to this date. [Mem., 7 Aug.]

Specimen 11. Argentite in pure white calcite, showing modified scalene dodecahedral crystals. There are several specks of argentite in the calcite. One of them marked *a* has the appearance of recent "growth." "Silver-growth" has commenced in the largest, *b*.

There is a small "silver-growth" at *c* unassociated with the ulphide.

No perceptible change to this date except a tiny silver-growth out of argentite, at *e*. [Mem. 7 Aug.]

Specimen 14 is a mass of argentite in white calcite, some of which is lamellar.

* This remarkable film, a portion of which Mr. Readwin kindly gave me, infusible in a gas flame, but slightly fusible before the blowpipe.—J.H.C.

In a druse, partly lined with modified scalene dodecahedral crystals, is argentite partly bright, and partly covered with the thin white coating. Here are no argentite-growths, proper, but a dozen or so of silver-growths have emanated therefrom, all having a reddish tarnish. These growths are all more or less crooked and twisted. Nearly all are turned up at the extreme point, and have a tendency to unite. Some of them appear *unions of exudations*, like some of the results of the experiments of Percy, Liversidge, Hutchings, and others, upon argentite at *low degrees of heat.*

No further alteration to date. [Mem., 7 Aug.]

Specimen 2 exhibits a bundle of more or less tarnished, fluted, and crooked silver "growths" in crystallized white calcite. There is no appearance of argentite, except a few minute specks.

The heavy weight of this specimen makes it probable that it contains a good deal of secreted argentite or silver. [Mem., 7 July.]

No further change to this date except a few instances of silver-fibre-extrusions, which look as if peeling off. [Mem. 7 Aug.]

No. 6 is a remarkably interesting specimen of argentite and silver "growths" out of amorphous pistacite-epidote, containing some crystallized white calcite.

The argentite "growths" are chiefly in the epidote; the silver "growths" chiefly in the calcite.

A silver-growth has *penetrated* into a fundamental rhombohedral calcite-crystal, and forced it up $\frac{1}{8}$ inch in its growth. This apparent hole-boring is extremely singular. [Mem., 7 July.] [Mem., Oct. 26]. This crystal has become detached.

No further change observable at this date. [Mem. 7 Aug.]

No 18 is a beautiful specimen of amorphous argentite in white calcite.

At one extremity of the argentite a shepherd's crook-like silver-growth has shot up, curved round, and taken another bend at its extreme end.

This growth, slightly tarnished, is double the length of the accompanying argentite. At its base, it is quite as wide. The growth has all the appearance of a "*union of fine filaments.*"

There are specks of argentite at one edge of the specimen, and some small silver-growths out of both argentite and calcite. [Mem. 7 July.]

No further alteration except some silver-filaments, which are, apparently peeling off. [Mem., 7 Aug.]

Specimen 94. The crystallized silver of this beautiful specimen is nearly all of it mixed up with rhombohedral forms of calcite attached to a larger fragment of calcite and purplish fluor, showing specks of copper pyrites and erubescite. The silver-crystals are, for the most part, cubes, more or less perfect, some of which are *particularly* interesting. [Mem., 7 July.]

No further change to this date, except a kind of foliation on the surface of one portion of silver. [Mem., 7 Aug.]

Specimen 123 exhibits perfectly bright white native silver-growths springing from crystallized white calcite, embedded in greenstone (?), which, probably, secretes argentite.

The calcite contains bits of apparently interjected greenstone and a little erubescite. At the base of the specimen, the silver is in a state of semi-crystallization.

In the upper portion are faces of silver-crystals; but towards the extremity, nearly two inches from its base, are two projecting straight, and one curved, silver-growth. [Mem., 7 July.]

No further change perceptible. [Mem., 7 Aug.]

I may mention that the majority of the silver specimens I saw at Kongsberg come fairly under the denomination "growth" and that it is simply impossible to find adequate terms in which to describe the singularity and beauty of some of them.

In one specimen argentite has shot through and through a calcite-crystal, and curled completely round.

Another shows native silver shot through a perfect rhombohedral calcite-crystal; then turned round, crozier-like, and has now a knotty bunch suspended therefrom.

There are many calcite-crystals joined variously together with threads of native silver; and one lovely crystal has silver-growths *inside* of it.

There is one intricately-twisted, and seemingly squeezed silver-growth out of calcite, which is joined to another flat piece of calcite; one portion of this growth is $\frac{3}{4}$ inch thick at its base.

An argentite-crystal has long, thick, curly-growths at one side, with silver in a crystallized state on the other.

A mass of argentite has beautifully twisted silver-growths, and some of them have the appearance of "frosted-silver."

Some of the argentite has a surface look of "landscape-marble."

One curious specimen of argentite is full of *circular* holes, in which calcite is said formerly to have been (?)

Native-silver also occurs here in leaves and flakes upon calcite-surfaces.

One very large recent specimen, composed of mica-schist, "quartz-glimmer," pistacite, purplefluor, &c., shows the usual mode of silver crystallization at these mines.

Another large specimen, composed chiefly of hornblende and mica-schist, with a string of calcite running through it, has silver crystallization like the last.

Mr. Corneliussen, at the mines, obligingly pointed out to me a very large stone which had just come from the workings. This after washing appeared nearly covered with more or less angular silver-spangles. Nothing could exceed the exquisite brightness of that virgin-silver.

I was informed that the silver in the argentite averaged 85 per cent. By analysis, about Ag. Sb S, 70; Ag. S. 30.

It is interesting also to note that, during the metellurgical operations at the reduction works with silver as the primary object, the following elementary substances have been extracted:—Au, Pt, Hg, Bi, Te, Sb, Th, Cu, Pb, Co, Se, and S.

NOTE.—According to *D. Forbes*, the Kongsberg native silver contains 0·40 per cent. Hg.; and Sæmann attributes the fine crystallization to its presence.

VI.—*Note on Uranocircite.*

By A. H. Church, M.A.

WHEN investigating the constitution of autunite* or lime-uranite, I secured an extremely fine specimen (of what was then supposed to be this mineral) from the mine at Falkenstein in the Saxon Voigtland. I was puzzled by the low percentage of water and other anomalous results which my analysis of the specimen in question gave. While at work upon the solution of this difficulty, Weisbach's note upon uranocircite or baryta-uranite appeared.† Winkler's analysis of the Falkenstein mineral clearly proves that we have in it a pure baryta-uranite—a new species of the uran-mica group. I did not, however, abandon my own researches into the nature of this mineral, for the mode in which the water was held by this mineral remained unknown. If isomorphous with autunite, it might be expected to contain 10 aq. in the molecule, 2 of which would probably be retained at 100° C. The following new analyses of uranocircite dispose of this hypothesis, proving that this species contains but 8 aq., 6 aq. being abandoned by the finely-powdered mineral either *in vacuo* over sulphuric-acid, or at 100° C, while the remaining 2 aq. require a strong heat for their elimination.

The central parts of large freshly-broken crystals of uranocircite from Falkenstein were crushed, picked over under a lens, and then finely powdered. These were the analytical results:—

I. ·411 gram *in vacuo* over H_2SO_4 lost—
·037 ,, H_2O, and gave
·097 ,, $BaSO_4$.

II. ·177 ,, lost on ignition
·027 ,, H_2O.

III. ·527‡ ,, *in vacuo* over H_2SO_4 lost
·038 ,, H_2O; at 100° C. it further lost
·013 ,, H_2O; and on ignition, a final loss of
·022 ,, H_2O.

* J. Chem. Soc., N.S., xiii, p. 109. † Jahr. Min., 1877, p. 407.
‡ After deduction of ·004 gram, insoluble matter.

.123 gram Ba SO_4 was obtained in the same analysis. Now the formula Ba O, 2 U O_3, P_2O_5 8 H_2O, demands these percentages :—

		WINKLER OBTAINED
BaO	15·08	14·57
2 UO_3	56·74	56·86
P_2O_5	13·99	15·06
8 H_2O	14·19	13·99

Of BaO my two analyses given above showed 15·58 and 15·32 per cent. respectively, while the total percentages of water which I found likewise closely accorded with those demanded by theory and with those obtained by the German analyst. But in my third and most complete analysis, I obtained results showing that the several molecules of water in uranocircite are not retained with equal tenacity. In the following table the conditions to which the powdered mineral was exposed, together with the percentage losses of water which it suffered corresponding to certain calculated percentages, are given :—

CONDITIONS.	EXPERIMENTAL LOSS.	THEORETICAL LOSS.
In vacuo over H_2SO_4 temp. 9° C to 16°	7·21	4 aq.=7·09
In air bath at 100° C	2·47	2 aq.=3 55
At a red heat	4·17	2 aq.=3·55
Sum	13·85	*8 aq.=14·19

Some further experiments have led me to conclude that at a temperature of about 20° C this mineral will lose 6 aq. by the removal of the atmospheric pressure and moisture. It then afterwards suffers no appreciable loss at 100°, while it retains at that temperature, just as autunite and torbernite do, the remaining 2 molecules of H_2O. Thus uranocircite resembles autunite in the ease with which its hold on the greater part of its water of crystallization is relaxed when atmospheric pressure and moisture are withdrawn; while its 8 molecules (not 10) of water bring it near torbernite. It will be instructive to compare these three phosphates from our present point of view.

*10 aq. correspond to 17·13 per cent.

	AUTUNITE	URANOCIRCITE.	TORBERNITE.
In natural condition	$\left.\begin{matrix}CaO\\2\,UO_3\end{matrix}\right\}P_2O_5$, 10 aq.	$\left.\begin{matrix}BaO\\2\,UO_3\end{matrix}\right\}P_2O_5$, 8 aq.	$\left.\begin{matrix}CuO\\2\,UO_3\end{matrix}\right\}P_2O_5$ 8 aq.
Dried *in vacuo*	$\left.\begin{matrix}CaO\\2\,UO_3\end{matrix}\right\}P_2O_5$, 2 aq.	$\left.\begin{matrix}BaO\\2\,UO_3\end{matrix}\right\}P_2O_5$. 2 aq.	$\left.\begin{matrix}CuO\\2\,UO_3\end{matrix}\right\}P_2O_5$ 8 aq.
Dried at 100°	$\left.\begin{matrix}CaO\\2\,UO_3\end{matrix}\right\}P_2O_5$, 2 aq.	$\left.\begin{matrix}BaO\\2\,UO_3\end{matrix}\right\}P_2O_5$, 2 aq.	$\left.\begin{matrix}CuO\\2\,UO_3\end{matrix}\right\}P_2O_5$ 2 aq.

I may mention, in conclusion, that Winkler's analysis of uranospinite, the rare calc-uran-arseniate from Schneeberg, does not conclusively prove it to contain 8 molecules only of water. The experimental numbers decidedly favour a formula with 10 aq.

	THEORY.	
	$\left.\begin{matrix}CaO\\2\,UO_3\end{matrix}\right\}As_2O_5$, 8 aq.	$\left.\begin{matrix}CaO\\2\,UO_3\end{matrix}\right\}As_2O_5$, 10 aq.
		EXPERIMENT.
Percentage of water	14·31	17·27 .. 16·29.

VII—*A Test of Specific Gravity.*

By A. H. Church, M.A.

IT often happens in mineralogical inquiries that from scarcity of materials, lack of time, or other causes, the important datum of specific gravity is not secured. Now, however, that Sonstadt has shown us how to prepare a nearly colourless and perfectly transparent liquid with a density three times as great as that of water, there will generally be no difficulty in ascertaining the specific gravity of very many rare minerals as to which our knowledge remains imperfect. More than this, two minerals if of different specific gravities (provided one is less than S.G. 3·0), may often be easily separated from one another if they are in fragments of appreciable size. Thus, pieces of quartz with a S.G. of 2.655 float, while fragments of beryl (S.G. 2·691) sink in a solution having S.G.=2·67. A very simple apparatus is required for the purpose. (See fig. 7, Plate. VIII.)

A small separating funnel A terminating in a glass stop-cock B, is mounted upon a glass bottle as a receiver. B. being closed, the mixed minerals, along with the solution, are put into A, agitated and freed from air bubbles (in the air-pump if necessary); then when, separation is complete, B is opened until the heavier mineral has been carried down into C. B is now closed so as to retain the floating mineral in A. A few repetitions of the process seldom fail in effecting such a separation in an hour as would have taken days, or been impossible by the ordinary method of mechanical selection. It is hardly necessary to say that the solution used, containing potassio-mercuric iodide, acts upon some minerals: it may be added that the washings from all specimens that have been wetted with the solution should be saved, as they need nothing but evaporation to reproduce the original liquid.

The usefulness to jewellers of Sonstadt's solution is obvious. One need possess but two strengths of this liquid (2·68 and 3·0), in order to be able to distinguish very many gems from one another. There should be at hand steel forceps, distilled water, and a few wide-mouthed squat bottles half full of the solution, into which the doubtful specimens are to be placed. Thus I have proved many

so-called white sapphires or white topazes to be beryl or quartz; once a parcel of "jacinths," for which a heavy price had been given, proved to be nothing better than burnt cairngorms. The densest solution I have yet obtained is one in which some transparent tourmalines (S.G. 3·01) neither floated nor sank. The preparation of this solution may be described in a single sentence. Mercuric iodide and potassium iodide are alternately dissolved in a saturated solution of the latter salt until no more of either compound is taken up. The resulting liquid may be diluted at will with water. If it were not for its honey-yellow colour, its high refraction and dispersive powers would tempt one to attempt its use, in lieu of carbon disulphide, for hollow prisms.

VIII.—*Note on "Romeite" from Borneo.*

By A. H. Church, M.A.

UNDER the name of Romeite a mineral from Borneo has found its way into many collections. There is, however, little in common between the true romeite of St. Marcel in Piedmont and the so-called romeite of Borneo. Both are hyacinth or honey-yellow with darker portions verging towards clove-brown; both contain antimony; here all resemblance ends. The easy solubility in acids, and the low specific gravity (under 2·0) of the Borneo mineral at once separate it from romeite; it is, in fact, nothing but a variety of allophane containing a little antimonious oxide. The following analysis may not be without interest; the mineral was selected and purified by mechanical means as far as possible, but still contained a small quantity of gangue, chiefly insoluble silica.

Analysis I.—·3285 gram lost *in vacuo* ·0567 gram H_2O; nothing further in the water-oven; but ·0078 gram at 100° in the air-bath. On ignition, a further loss of ·068 gram occurred.

Analysis II.—.4218 gram, after having been washed and slightly dried in the water-oven, gave—

Insoluble Silica	·0228	gram
Soluble Silica	·071	,,
Antimonious Oxide	·006	,,
Alumina	·165	,,
Calcium carbonate	·005	,,
Magnesium pyrophosphate	·005	,,
Ferric oxide	trace	,,

Analysis III.—·255 gram of the same sample as that used in Anal. II gave on ignition,

Water ..... ·095 gram.

When the results obtained in these analyses are corrected for insoluble silica, and in II and III, for partial desiccation, they yield the following percentages:

Water lost *in vacuo* over H_2SO_4	18·53 per cent.
,, ,, in the water oven	none
,, ,, in air-bath at 100°	2·51
,, ,, on ignition	21·84
Alumina	39·02
Lime	·66
Magnesia	·33
Antimonious oxide (Sb_2O_3)	1·42
Silica (soluble)	16·79
	101·10

Were it not for the low percentage of silica these numbers might represent one of the minerals included under allophane, an attribution which the physical properties of the present mineral confirm. Moreover, some specimens, at all events, of allophane lose, exactly as our Borneo mineral loses, half their water at 100° C. If we assume that the silica deducted as insoluble, and therefore as an accidental impurity, was really essential, then the numbers would approach more closely to those required for an allophane.

IX.—*On a Curious Blast Furnace Slag.*

By J. B. Hannay, F.R.S.E.

ONE of the blast furnaces at the the Eglinton Iron Works, Kilwinning, having been blown out, it was noticed that on the hearth there was a curious deposit of a bluish black semi-metallic colour, which by its brittleness seemed to be a slag. Mr. Smith having forwarded to my friend Mr. John Young, F.G.S, a sample of the substance, it was submitted to me for analysis and examination. On a cursory examination it was seen that it was not homogeneous but consisted of different substances mixed, the most conspicuous being the bluish substance with a plumbago lustre before referred to. On powdering it the substance was found to contain pieces of metallic iron in irregular masses inbedded in the matrix. This Iron had likely been splashed in amongst the slag, as it did not seem to belong to it, and was very irregularly distributed throughout the mass. Several portions had a reddish colour and did not look like the general mass, but were, as will be seen, of an entirely different composition. The substance in powder had a specific gravity of 3·839, but when freed as much as possible from metallic iron by means of a magnet, its specific gravity was lowered to 3·751. A qualitative analysis showed that the substance contained carbon as "kish," silicon, silica, titanium nitrocyanide, iron, manganese, calcium, magnesium, sulphur and phosphorus. In the bluish portion the manganese was in large excess, whilst in the reddish the calcium and magnesium increased so as to be nearly equal to the manganese. The great bulk of the slag, however, consisted of the bluish substance. The following is an analysis of an average sample of the slag.

Insoluble in Hydric Chloride	Carbon, Silicon and Silica	15·51
	Titanium nitrocyanide ..	5·27
	Iron	18·31
	Manganese	30·51
	Calcium	4·45
	Magnesium	5·16
	Sulphur	18.28
	Phosphorus	2·17
		99·66

If we leave out the iron we find that there is not enough sulphur and phosphorus to saturate the remaining metals, so that we must suppose either that a portion of the manganese existed in the metallic state, or as a carbide or as a lower sulphide. It may be that all three cases may have existed, but as I could not free the pieces of iron from all adhering matrix I had no means of knowing. Two other portions were analysed, one a picked sample of the blue portion and the other of the red. The following are the analyses.

		I	II
Insoluble in Hydric Chloride	Carbon, Silicon, and Silica	18·04	16·34
	Titanium nitrocyanide ..	4·88	7·01
	Iron	19·06	16·47
	Manganese	35·52	20·53
	Calcium	0·85	12·07
	Magnesium	2·07	8·45
	Sulphur	17·64	18·72
	Phosphorus	1·01	0·14
		99·07	99·73

It will be noticed that in these analyses the sulphur and phosphorus are again too low to form mere sulphides, so that some of the metals, besides the iron, must have been either in the metallic state or in a lower state of combination.

X.—*Memoir on Crystallogenesis.*

By Karl Ritter von Hauer.

Read at the Meetings of the Imper. Geolog. Institute of Vienna, in February, March, and July, 1877. (Communicated by Count Marschall).

ABSTRACT.

Variable Degrees of Crystallizing Force.—A tendency to assume crystalline forms is a property of all crystalloids; its full or imperfect development depends on external circumstances.

Crystals produced in laboratories are generally inferior to natural crystals of the same substances, probaby because of their too rapid formation. The faculty of crystallization is modified by specific dispositions inherent to the substances. There are many distinct types of crystallization, connected with each other by intermediate types, and even with a transition from amorphous to crystallizable substances.

The degree of distinctness of crystals constitutes a fundamental difference. The crystals of many substances are distinct, while below a certain limit of size; but when this is exceeded, the surfaces are interrupted by re-entering angles, or by irregular drusy cavities or excrescences constantly re-appearing when cleft away, so as, at last, to completely destroy their individuality and regularity.

A higher power of crystallization must be ascribed to substances whose crystals preserve their surfaces uninterruptedly, even when of considerable size. Such crystals may, indeed, exhibit local irregularities, due to the too rapid increase such as may be provoked by sudden changes of temperature. These defects, however, are subsequently repaired, while in less crystallizable substances they become more and more striking.

The artificially mutilated crystals of certain substances, when plunged into saturated solutions, are very soon converted into perfect crystals. Some substances crystallize easily in isolated individuals, others in irregular aggregations or in binary groups. Certain crystals, especially after having arrived at a large size, are constantly

affected with partial irregularities (rough, uneven, or ribbed surfaces, rounded edges, &c.) appearing always on similar points, the rest of the crystal remaining quite regular.

Crystals of many substances, surpassing in symmetry any natural ones, may be obtained by keeping them suspended in a solution, occasionally changing their position. Independently of the degree of solubility, the crystals of some substances increase very rapidly; others very slowly; some appear in pellucid, others in opaque crystals.

Some substances, although frequently occurring in amorphous or indistinctly crystallized forms, are occasionally under circumstances not yet sufficiently cleared up, obtained in well-shaped crystals. Many substances, especially organic ones, possess a very imperfect power of crystallization, appearing only in the form of dendritic crystalline aggregations, scales, tubercles, or fibres. Such are pyro-racemate of magnesia, glycolate of baryta, oxalate of lead, malate of yttria, itaconates of soda, methylo-sulphite of potash, asparagate of zinc, tartrates of baryta, antimony, &c.

Substances occurring as crystalline powders rank not absolutely under this category. Many of them, when magnified, prove to be aggregations of isolated and regular crystals, capable of undergoing normal increase in time and under favourable circumstances. Within four years crystals of ammonia-platino-chloride of the size of a pea, and acetate of soda-uranium of the size of a nut, have been obtained, both of quite regular form.

The limit of increase between regular and abnormal modes of formation is not the same for all crystallizable substances; nor even for the same substance under varying circumstances. Sulphate of potash, acetate of potash-uranium, chloride of barium, chlorate and dithionate of potash, &c., may serve as types of the loss of regularity accompanying the increase of volume. The crystals of dithionate, quite regular as long as they remain small, become irregular and even altogether indistinct as soon as they have reached a moderate size.

Substances possessed of such a power of crystallization that their fragments easily complete themselves to perfect crystals, are not numerous. Such are: iron and chromium-alums, sulphate of cadmium, borate of soda, citric acid, malate of ammonia, citrate of soda, citrate of ammonia with excess of acid, acetate of soda-uranium, dithionates of lime and strontia. The time in which this com-

pletion is perfected essentially depends on the degree of solubility of the substances; which easily take the form of isolated individuals, frequently achieve a notable volume, and are scarcely affected with irregularities even under the most unfavourable circumstances.

Some substances so constantly crystallize into binary groups, that this tendency must be considered as essentially inherent to them. Such are: ferric and cobaltic cyanides of potassium, succinate of soda, valerianite of copper, &c.; and these are connected by intermediate terms with other crystallizable substances.

In crystals inclined to partial defects of formation, these defects are often strictly localized, the rest of the crystal exhibiting such characters as specular surfaces, sharp edges, &c., in perfection. In some substances these defects appear from the very first, in others only in crystals arrived at larger dimensions. Although the increase of such crystals progresses uniformly at every point, the characteristic defects never disappear, and must therefore be considered as essentially inherent to the substance.

The cyanide of potassium and nickel crystallizes in the shape of monoclinous tabular crystals, whose terminal surfaces are constantly opaque and ribbed, those of the prism remaining quite smooth and bright. Oxalate of iron-potash always exhibits a pair of striated surfaces. Arseniate of potash and phosphate of ammonia constantly show curved and opaque prismatic surfaces whenever their crystals have reached a considerable volume.

Formiate of cadmium-baryta, however minute its crystals may be, always has notably striated prismatic surfaces.

The result of over-hasty crystallization, as it takes place in industrial operations, proves that the origin of opaque crystals is not exclusively due to the irregular disposition of their mineral particles. Frequently crystals so produced are as regularly formed as those issuing from slow increase under sedulous care. Most of these substances, limpid in their origin, grow opaque only when having arrived at a considerable volume.

A study of chemical literature shews that a great many crystallogenetic experiments have been conducted under most unfavourable circumstances. Thus, the physical properties of many crystallized substances are merely derived from crystals obtained by cooling from hot saturated solutions.

PRESENCE OF FOREIGN SUBSTANCES.—The presence of a heterogenous substance in a solution acts in a constant and regular way on the crystallization of the dissolved substance. Whenever the admixture is identical with one of the components of the dissolved substance, it merely alters the proportion of its equivalent. In no case are these admixtures embodied into the products of crystallization and their mode of action is as yet wrapped in the deepest obscurity. It has been ascertained that chloride of sodium, which generally crystallizes in cubes, assumes the form of octahedra by the presence of a little urea in its solution, and binoxalate of ammonia crystallizes in peculiarly disfigured forms out of a solution containing a minute proportion of antimony.

There are still other striking instances of this action. Aceto-nitrate of strontia, easily to be obtained in very large crystals, crystallizes out of a neutral solution with conspicuous terminal surfaces of truncation, of which not the least trace appears when acid prevails in the solution. Chlorate of soda crystallizes out of its unmixed solution into cubes with some hemihedral surfaces. The admixture of sulphate of soda calls forth most perfect tetrahedra with conspicuously three-faced solid angles, and more or less developed hexahedral surfaces. Sometimes such crystals come to considerable size, still remaining perfectly regular. Together with them, other crystals are disfigured, so as to offer the aspect of prisms.

Sulphate of nickel with six atoms of water crystallizes in quadratic pyramids under a temperature between 30° and 40° C. When the solution contains a small proportion of nitric acid, the angles of the pyramids are conspicuously truncated. This may occasionally be observed in crystals formed in an unmixed solution, but then only in a slight degree as long as the crystals remain small. This hydrate crystallizes under a temperature little above 20° C. out of a solution containing a great proportion of free sulphuric acid, provided the evaporation is going on within a closed space and above a substance absorbing water ; chloride of barium appears in conspicuously large and regular crystals, when its solution contains traces of chlorides of zinc, cadmium, or mercury.

Nitrate of lead, when crystallizing out of a neutral solution and having grown to some size, is milk-white and opaque. A hot and moderately heated solution, containing free nitric acid, gives, when cooled, transparent and bright crystals with many surfaces.

Sulphate of potash-manganese is only obtained in fine crystals out of solutions in which sulphate of manganese exists in rather notable excess. Such an excess, in smaller proportion, is an absolute condition of its existence. A solution conformous to the proportion of chemical equivalents, when abandoned to spontaneous evaporation, deposits only pure sulphate of potash during a certain time, the excess of sulphate of manganese remaining in the solution.* Acetate of copper-lime crystallizes only from a solution with a notable quantity of acetate of lime. When re-crystallized from its solution in water, acetate of copper is obtained before the double salt. This change is indicated by a change of colour. Hot water, sufficient for a complete solution, takes a green tint in contact with the double salt, having dissolved only acetate of copper. This, having partly crystallized out of the cooled solution, the rest of the solution assumes the beautiful intensely blue tint characterising the bi-basic salt. The same effect is obtained by adding some acetate of lime to the solution. The crystals of the bi-basic sulphates of peroxides of iron and potash or ammonia, separating from a solution with some excess of free sulphuric acid, are conspicuously disfigured and irregular. All these phenomena and many others of the same nature, although ascertained by way of experiment, still remain unexplained as to their causes. Probably they are more frequent than is generally thought, and such causes may have been active in the formation of minerals, impressing on them the crystalline forms which are so often characteristic of certain localities. Certain substances might not be under exactly the same crystallographical and chemical conditions more than once, even after repeated trials ; nor could the cause of success or non-success be sufficiently ascertained.

Whoever works simultaneously with many solutions, whose degree of purity is not sufficiently known, and of which some may be forgotten for a time, is likely to meet with quite unexpected results. Casually formed crystals may, at times, far exceed in perfection those on which the greatest care has been bestowed. Sometimes the chemical nature of crystals is different from the composition of those which are ordinarily deposited by the solution. This is

* These crystals offer a notable instance of the action of mechanical mutilation. If one extremity of these lengthened tabular crystals is broken away, the regularities of the surfaces at the opposed extremity disappear in the course of increase ; cavities take their place, and the continuity of the structure is disturbed.

especially the case with hydrates. Heterogenous substances present in the solution may be productive of new crystallized combinations, whose nature, indeed, may be ascertained by chemical analysis, but which cannot be re-produced, although their constituents are brought together in the same proportions and apparently under the same circumstances. Failures in the reproduction of crystallizable chemical combinations would not therefore be a sufficient reason for denying their real or possible existence.

EFFECTS OF TIME.—A limit of increase in crystals is properly speaking not observable. Many substances, however, even while their crystals have not increased beyond a relatively small size, lose their regularity by unconformous aggregation of their molecules, and grow up into shapeless conglomerations without a trace of crystallographical individuality.

The apparently most perfect crystalline surfaces, when examined under a magnifying glass, offer a great many irregularities, such as striations, furrows, &c. When strictly measured, the angles of the individuals of one and the same substance offer slight differences. The juxta and super-position of the molecules, by whose aggregation crystals are constructed, are not subject to the rigour of geometrical rules, and any crystal may bear in itself a tendency to irregularities becoming more and more conspicuous as it increases in size. During the increase molecules may be again aggregated in a regular way, thus parallelizing the irregularities; this process, however, seems not to continue over the whole surface, and, in general, large crystals are not so regular as smaller ones of the same species. No such disfigurations, as they appear on artificial crystals submitted to a long-lasting increase in our laboratories, are conspicuous on crystals of minerals, whatever may be their occasionally colossal size. Probably their formation has progressed in a less hurried way, in consequence of the very low degree of solubility of their component substances in their respective menstrua. The most perfect artificial crystals are obtained from difficultly soluble substances. Whenever such a substance possesses a high faculty of crystallization, so that its first crystals are not affected with disfiguring irregularities, an increase continued through years may produce crystals as large and as perfect as any natural ones.

The increase of volume, without regard to irregularity is unlimited; increase with preservation of the original regular forms is limited, at

least in many substances. Experiments, continued through years with more or less soluble substances, have not led to finding out a term of their increase as individuals. A number of substances possessing the faculty of forming large crystals achieve a notable size within a few days. Others remain very small, even minute, during the same time, but may achieve the same size as the first ones, by successive and long-continued increase. The time of increase is a specific quality of the substances independent of their degree of solubility. The racemates of potash and soda are nearly equally soluble; however, the last one appears in* small crystals, achieving scarcely in years the size to which the first one arrives in as many months, although with an indefinite space of time it may be formed into large regular crystals. Borate of soda is difficultly soluble in comparison with racemate of soda, yet it appears at first in far larger crystals, and its increase, during the spontaneous evaporation of both solutions, proceeds with far more celerity.

The absolute size of a crystal is no criterion of the time of its increase. The substances generally quoted as forming "large crystals" are, for the most part, those first appearing in considerable size. Those characterized as forming "small crystals" are such appearing first in minute size, not including their further increase. As to the first class, a few primary nuclei attract the whole of the fixed substance contained in the solution; as to those of the second class, many such nuclei exist in the beginning, each increasing at the expense of the dissolved substance.†

Whenever the quantity of this substance exceeds the power of increase of the already formed crystals, new primary nuclei are formed. These phenomena are conspicuous, both in hot saturated solutions gradually cooled, and in solutions left to spontaneous evaporation. Crystals of quite astonishing size may be obtained in short times whenever the quantity of substance in solution accords with the power of assimilation of the primary nuclei, and the substance itself is endowed with an energetic faculty of increase. Sulphates of iron and copper, acetate of lead, tartaric acid, &c., in enormous crystals, are obtained by industrial operations. Such crystals have been left to increase during a long time without any

* The first appearing crystals are those which become visible at the cooling of a hot saturated solution, or at the first beginning of spontaneous evaporation.

†Nearly all solutions when left in complete repose for some time, become supersaturated.

alteration of their normal structure. Chlorate of potash, resulting from identical industrial operations, constantly appears in thin lamellæ, never coming to a notable size by slow increase without undergoing complete disfiguration. In a solution saturated when hot and left to cool, the amount of dissolved substance, accessible to the primary nuclei, must be proportional to the volume of the solution, and to the difference of solubility in heat and after cooling. Whenever a solution is brought to crystallization by spontaneous evaporation, the volume of the solution acts on the quantity of crystallizing substance, together with the degree of super-saturation, which it comes to when left to repose.

Super-saturation is, in many cases, an abundant source of increase to the first-formed crystals. The difference between a normally saturated and a super-saturated solution is sometimes not more notable than the difference of a solution saturated when hot and subsequently cooled. Rapidly increasing crystals of substances whose solutions are capable of bearing a high degree of super-saturation, acquire in a few days remarkable dimensions in a cool solution left in absolute repose. Such are arseniate of soda, oxalate of ammonia-chromium, &c.

Another group of substances, apt to appear in large crystals, show this faculty only when due time is left to them. Such are, chlorate of baryta, hypo-sulphate of soda, platino-cyanide of magnesium and many others. The circumstances prevailing at the first do not re-appear, thus the increase is never again as rapid as it was in the initial period of formation.

MECHANICALLY INDUCED VARIATIONS.—Conclusions from the size of any crystals, as to the time occupied in attaining their present volume, are only admissible whenever the specific faculty of crystallization of the substances in question is known; and this may probably be the case for natural as for artificial crystals. The formation of some substances may be likewise modified by mechanical operations, as filing, polishing, or cleaving, and subsequently leaving them to further increase, till they are again completely wrapped up into really crystalline surfaces, which occasionally adapt themselves, wholly or partially, to the form of the mechanically modified crystal. Experiments prove the possibility of modifying the crystals treated in this way, by increasing their symmetry or their irregularities, by imparting extension and

permanence to inconspicuous or easily disappearing surfaces, or by calling into existence new secondary surfaces. Substances completing themselves in this way or out of amorphous fragments, into individual crystals, are endowed with an eminent power of crystallization. Professor Frankenheim has tried to explain the increased assimilation of substance along the mechanically altered portion of crystals, by supposing an increase of superficial attraction, the rough fracture of a crystal offering a greater surface than any smooth surface. In fact, however, the increase of superficia-attraction in not proportional to the excess of substance adhering to the altered points over the amount adhering to the portions left unl altered. The faculty of spontaneous completion is most conspicuous in sulphate of cadmium, citrate and racemate of soda, bi-malate of ammonia, phosphate of ammonia, dithionates of lime and strontia, &c., as also in some bi-basic combinations as acetate of soda-uranium, ferro-cyanide of potassium, &c. Acetate of uranium-soda, especially in large crystals, offers but slight traces of the three planes at the angles of the tetrahedron, and frequently these surfaces are wholly wanting. They may be obtained to any extent by breaking the tetrahedral angles and by filing away the three edges thus obtained. The ferro-cyanide of sodium crystallizes in tetragonal, less frequently in hexagonal prisms, with four opaque and uneven and two specular surfaces, these last disappearing in the course of increase, but obtainable to any extent by repeated filing in the progress of increase.

Phosphate of ammonia crystallizes normally in lengthened prisms, pointed at both extremities. It may be obtained in short and thick prisms, with conspicuously developed terminal points, by repeatedly breaking away both points.

The twelve secondary surfaces of the dithionates of lime and strontia are more fully developed by repeated breaking away of their edges. Borate and citrate of soda, like bi-malate of ammonia, may be modified at pleasure by a repeated cleaving of their crystals. The symmetrical evolution of crystals by increase of imperfectly developed surfaces, may be promoted by keeping the increasing crystals lying on these surfaces. This proceeding is, of course, only applicable to a limited number of surfaces, and in general only on crystals of the regular and quadratic systems.

VARIATIONS OF TEMPERATURE.—There is a greater number of substances on whose crystals secondary surfaces may be produced,

by exposing them to partial solution and afterwards leaving them to further increase within a spontaneously evaporating solution. A crystal, placed repeatedly in an incompletely saturated solution of its own substance, has its angles and edges rounded, its surfaces being but slightly altered. When brought again into a saturated solution, many crystals acquire new surfaces on the rounded places, which surfaces generally disappear whenever the volume increases notably.

The multiplication of surfaces on crystals, subsequently to their partial dissolution, appears most completely and conspicuously when this alternation of dissolution and regeneration proceeds spontaneously, as is the case under varying temperature. As soon as the temperature of the air in contact with the solution is rising, the crystals, already formed in the solution, are partly dissolved. In the progress of spontaneous evaporation the solution becomes moderately super-saturated, and is most fit for the production of crystals, provided it be kept in absolute repose and secured against subitaneous diminutions of temperature. The disturbances caused by variations of temperature are more or less apparent, according to the degree of solubility of the substances contained in the solution.

A number of substances are characterized by an excessive sensibility to the least agents disturbing crystallization. Their initial crystals, however correct they may be, when slightly disturbed in the progress of increase, lose their regularity and become scaliform. They are easily influenced by variation of temperature, and thus can never be obtained in voluminous crystals. Most of such substances are easily soluble, although a high degree of solubility could not be considered to be the only cause of their characteristic peculiarities. Nitrate of potash appears, at first, in well-formed crystals out of a super-saturated solution. When they are repeatedly turned in order to obtain their increase, they change their shape nearly day by day, and become more and more deformed by alternations of partial increase.* The same is the case with nitrate of soda and with the anhydrous hexagonal chloride of ammonia and cadmium. The tendency to alternating partial abnormal increase, and consequently to deformation, is most conspicuous on the sodium-platinum-chloride Dithionate of potash and nitrate of lead (this last rather difficultly soluble) offer a constant change in the formation of their edges and

* Large and regular crystals of nitrate of potash can only be obtained by industrial operations on a large scale.

surfaces, part of which become uneven and rounded, while the rest is acute and specular. While defective portions of the crystals are completed to regularity, others of regular shape become irregular.

The crystals of certain substances are subject to be disfigured by fissures, especially when they are come to a certain size, and these fissures, which are produced by changes of temperature in the solution do not correspond with the natural cleavages. Crystals kept out of solution are free from such alterations. The change of summer and winter temperature has not visibly affected a collection of several thousand crystals, preserved in an unheated room. As, generally, the molecules of crystals are grouped in such a way that coherence is looser in a certain direction than in any other, there may exist, in some substances, a condition of tension in these molecules, so that, in consequence of a slight degree of expansion or contraction, rupture of continuity takes place in every direction. Among several hundreds of crystals of dithionate of strontia, not one has exceeded the size of a lentil without being disfigured by a number of irregular fissures. The fragments marked by these fissures are easily completed into crystals, which, however, as they increase, are soon cut through again by fissures. When affected by external mechanical action, the fragments of such crystals, as far as they are free from fissure, offer a notable degree of resistance. These fractures do not generally extend through the whole dimensions of a crystal. In this last case a continuous crust is never again formed around the crystal, the fissure persisting as its volume increases.

SPONTANEOUS DECOMPOSITION OF CRYSTALS.—Many crystals lose their water of crystallization even under ordinary temperatures, being thus easily subject to decomposition. This quality is so variable in intensity, that no distinct limits can be traced to its action, the more as the loss of water of crystallized hydrates depends, in some circumstances, as much on the pression and on the hygrometric condition of the atmosphere, as on the degree of temperature. Crystallized substances, not losing any water under open air and under a certain temperature, lose it in a short time and under the same temperature when placed under the air-pump, or in an enclosed space, above substances attracting water, as sulphuric acid, or chloride of calcium. The bi-basic sulphate of nickel and potash, with six molecules of water, does not lose the least portion of it,

when subject during some time to a temperature of 100°C. The highest hydrate of arseniate of soda exposed to a temperature of 100°C., is reduced to powder within a few hours.

The greater number of crystallized substances, subject to spontaneous decomposition by loss of water in open air, are entirely reduced to powder. Some few hydrates having lost part of their water, preserve their original form, but lose their pellucidity. The fine crystals obtained from a mixture of the solutions of the sulphates of cobalt and zinc are soon decomposed without notable loss of consistence, their surfaces even remaining faintly bright. The same is the case with the crystals of sub-sulphate of lead, iron-alum, bi-basic sulphate of soda and lithium, &c. Some substances, as sulphate of copper, chrome alum, ferro-cyanide of sodium, etc., slowly decomposed in the open air, remain unaltered when carefully protected against its destructive action Kept under hermetically closed glass bells, such crystals remain unaltered for 10 to 12 years. The resistance to the destructive action of air, may, in some few cases, be increased by admixture to the solution from which the crystals are obtained, of a solution of an isomorphous combination offering more resistance to this destructive action. The progressing decomposition of sub-sulphate of lead may be avoided by mixing the solution with a small proportion of isomorphous sulphates, as those of lime or strontia.

Iron-alum, a substance extremely subject to decomposition, when a little alumina-alum is added to its solution, may be so far secured against destructive agents, that its crystals remain unimpaired within a closed space. The uncommonly beautiful crystals of formiate of copper are soon decomposed into a white powder, even within a hermetically closed space. An admixture of some formiate of baryta or strontia, both crystallizing in variable proportions, unite with the formiate of copper, without altering its crystalline form, and impart to this last salt the power to preserve its integrity within a closed space. This last case is the more remarkable as the formiates of baryta and strontia crystallize in forms of the rhombic system, without being isomorphous, while the crystals of formiate of copper, either pure or mixed with the above named formiates, are monoclinous and isomorphous.

ACTION OF LIGHT.—Many facts concerning this action, especially on silver-salts, have been published. Formiate of lime exposed

during a long time to direct sunlight undergoes chemical alteration attended with mechanical destruction. A number of splinters are loosened from the crystals and projected with a certain degree of violence, no doubt by gaseous substances developing within the crystals. These being preserved in hermetically closed glasses, this development of gas can only be ascribed to internal molecular movements under the action of light. Large crystals of bi-basic formiates of copper and strontia placed under the same circumstances showed extensive black spots, and within some months became completely black. This alteration penetrating to the very centre of the crystals, affected neither their consistency, nor the very striking brightness of their surfaces. A similar mechanical action of light has been ascertained on formiate of cadmium, and on nitro-acetate of strontia. The crystals of oxalo-chromate of potash, pure or mixed with the bi-basic oxalate of ammonia and chromium, become opaque by exposure to light, without suffering further alteration. The bi-basic oxalate of chromium and ammonia is not altered by light.

FIRST FORMATION OF CRYSTALS.—The only rational and invariably successful way of obtaining isolated, not over-minute, and correctly formed crystals, whose volume may be progressively increased, is the method long ago commended by Leblanc, by spontaneous evaporation of solutions. Saturated solutions mixed with some little water, to retard the instantaneous formation of crystals, are placed in shallow dishes with flat bottoms and left to absolute repose. The size of the first formed crystals within a certain space of time depends on the volume of the solutions within them. When left in undisturbed repose, conditions of super-saturation, most favourable to the first formation of crystals, nearly constantly isolated individuals, fit for further increase, are found among the crystalline aggregations. Even crystals of difficultly soluble substances may come to notable dimensions in the course of beginning crystallization; it is, indeed, the only way of obtaining such substances under the form of isolated individuals fit for further progressive increase. Hot saturated solutions of easily soluble substances, when allowed to cool, give rise at the same time, to very voluminous compound crystals, provided the due degree of concentration has been found out, and also to isolated individuals. Generally, however, such crystals are imperfect in structure, these imperfections becoming more and more striking as they increase in

size, nor are they possessed of the degree of pellucidity proper to these substances. In over-saturated, as in hot cooling solutions, an over-hurried crystallization may take place, being indicated by the notable increase of crystals in a short period. In both cases the process of crystallization goes on more rapidly than within a not over-saturated solution left to spontaneous evaporation. The regular formation of any crystal seems to depend less on the celerity of the minimal particles deposited around the original nucleus, than on other disturbing circumstances. In an over-saturated solution of constant temperature, no movements take place capable of disturbing the normal deposition of fixed particles, set free on the surface of crystals in way of increase. The periods of repose, as those of disturbance, leave distinctly perceivable traces on crystals, especially on large and pellucid ones, whose increase has required a long period of time.

XI.—*Contributions to the Mineralogy of Nova Scotia.*

By Henry How, D.C.L., Professor of Chemistry and Nat. Hist., University of King's College, Windsor, Nova Scotia. (*Corresponding Member.*)

(Continued from L.E.D. Phil. Mag., Feb., 1876.)

1, Cryptomorphite and Priceite not Identical in Crystalline Form.

IN 1861, I described (Edinburgh New Philosophical Journal, and American Journal of Science) a borate, found with glauber salt in gypsum at this place, as a new mineral, by the name of Cryptomorphite, on account of its amorphous appearance to the naked eye being resolved into one most distinctly crystalline, under the microscope.

The first criticism on the mineral was made by Prof. Geo. J. Brush (Tenth supplement to Dana's Mineralogy), who said, in effect, that it could not be accepted and named as a new and distinct hydrated borate of soda and lime, because there were already too many names in use for minerals, not clearly made out to be distinct, having more or less closely similar composition. Professor Dana, however, was of a different opinion, for in a letter dated Nov. 5th, 1867, referring to a specimen I had sent him, he said "Cryptomorphite appears to be unquestionably a good species." In the American Journal of Science for August, 1872, it was announced editorially that cryptomorphite occurs in Nevada in nodules from 4 to 6 inches to as many feet (*sic.*), with the appearance of French prepared chalk; the deposits were said to be extensive, but the discoverer declined to tell the locality. The mineral was found to be a "form of borate of lime." The next year, two papers appeared in the same journal, one in April, on "oregon borate of lime (cryptomorphite?)" by A. W. Chase; the other in August

"Mineral notes on Utah, California, and Nevada, with the description of priceite, a new borate of lime," by Professor Silliman. This new borate of lime was the oregon mineral, and the author gave it the name priceite after stating that "this mineral is clearly different from the cryptomorphite of How, to which it has been provisionally referred by Price and others. It has the microscopic crystallization described by Dr. Robb as belonging to the Nova Scotian species, but the absence of soda and the greater ratio of protoxide base carries it much nearer to hydro-boracite, from which it is separated by containing no magnesia and less water."

The description of the crystallization of cryptomorphite alluded to as observed by Dr. Robb, of Fredericton, New Brunswick, in 1861, is as follows, in a letter to myself, soon after I had sent him a specimen for examination. "The mineral just as I got it, untouched and unwashed, is perfectly crystalline in every particle. A good power is required, but with a magnifying power of about 350 diameters there is no difficulty, the form comes out as sharp as possible. The crystals are excessively thin translucent tables or plates. They have a rhombic outline, and the angles probably = 80° or more. Owing to the excessive thinness I could not say whether they could be called right or oblique rhombic prisms; I suspect the latter from analogy. The plates are about ·0048 of an inch from side to side, but some are a little larger, others a little smaller. In some you see a regular cleavage—that is, a small rhomb chipped out of one side. I presume it was formed in a dry place, for the angles were quite sharp."

The characters of the oregon borate under the microscope agree closely enough with this description to have led to the confounding of it with the Nova Scotian mineral in the first instance. My object just now is to show that the crystalline forms of the two are, however, really quite distinct.

The excessive thinness of the crystals of cryptomorphite was sufficiently striking to call for a repeated mention by the first observer with the microscope, Dr. Robb, and was soon after seen by myself. Now, priceite, for specimens of which I am indebted to Professor J. D. Dana, of Newhaven, and to Professor G. Davidson, of San Francisco, exhibits most unmistakeably much thicker rhombic plates. Again, some of the angles of cryptomorphite are given by Robb as = 80° or more, while those of priceite corresponding are considerably more acute, about = 50°; and, still further, a much

lower power suffices to bring out the crystals of priceite than is the case with cryptomorphite, so that their measurement would much exceed that for the latter as given above by Robb. Mr. S. D. Mills, who kindly went through the comparative observations with me under his own microscope, said he should have no difficulty in separating the two minerals by their form. These observations complete the distinction first shewn (*loc. cit.*) to exist between cryptomorphite and priceite, on chemical grounds, by Professor Silliman. The comparative quantities in which the two minerals have been met with is also worth notice. While the latter is in large masses, measured by feet, in considerable deposits, the former has been found only in very small nodules, not longer than a pea, imbedded in glauber-salt, in one thin vein between gypsum and anhydrite. No doubt a good deal has been thrown away as "salts." I have only been able to secure a small quantity once since the original finding, though I have from time to time asked the quarrymen, when working at the part of the rock holding the vein, to save me "the salts." All I have ever had amounted to less than 100 grains probably of cryptomorphite, washed free of impurity, and a pound or two of glauber-salt holding the mineral, and mixed with fragments of gypsum.

2. Silicoborocalcite, *How* (Howlite, *Dana*) Reported in Large Nodules.—I may recall that this mineral has been met with in the chalky form at Noel, Hants. Co. (contrib. IV. Phil. Mag., April, 1869), about 40 miles N.E. of Brookville, where it was first obtained in small nodules, both hard and chalky (contribution III, Phil. Mag., Jan. 1868), for the purpose of recording that it has since been reported to occur at Noel, in nodules sometimes as large as a man's head.

3. Tabular View of some Allied Borates.—As the foregoing and some other hydrated borates of sodium and calcium, or of the latter alone or with silica, are confounded, I may mention as further examples, that I saw mentioned in a printed catalogue of an eminent British collector, a specimen of "Howlite in fibrous crystals—a form not assumed by the mineral—it was doubtless ulexite; and in the elaborate catalogue of an American mineralogist, cryptomorphite is named where the mineral is certainly priceite, and as their composition and characters, as lately ascertained in some cases, are nowhere collated, the following table may be useful; the minerals are all white.

MINERALS.	FORMS.	LOCALITIES.	EMPIRICAL FORMULÆ.
Ulexite.	Acicular prisms, and fibrous layers and nodules, dull and of silky and satin-like lustres.	S. Peru; Bolivia; Nevada; Arizona; W. Africa; Hants Co., Nova Scotia.	$Na_2O.2CaO.5B_2O_3.15 H_2O$. How.
Franklandite.	Fibrous nodules.	Tarapaca, Peru.	$2Na_2O.2CaO.6B O_3.$ $15 H_2O$. Emerson-Reynolds.
Cryptomorphite.	Very small chalk-like nodules, shewing *mic.* very thin rhombic plates of about 80°	Windsor, Hants, N.S.	$Na_2O.3CaO.9B_2O_3.12 H_2O$. How.
Priceite.	Large chalk-like nodules, shewing *mic.* thick rhombic plates of about 50°	Chetko, Sea Coast, Curry Co., Oregon.	$CaO.4B_2O_3.6H_2O$. Silliman.
Hayesite.*	Fibrous nodules.	Bolivia, Peru.	$CaO.2B_2O_3.6H_2O$. Hayes.
Howlite.	Highly pearly, scaly, & amorphous nodules.	Hants, Co., N.S.	$4CaO.5B_2O_3.2SiO_2.$ $5 H_2O$. How.

*At the dry Lake of Maricunga, Borocalcite (Hayesite) is estimated to exist to the amount of 14,000,000 tons, mixed with Nacl, but without Ulexite, (natro-borocalcite). See Silliman's Jrnl., August, 1874.

Reviews and Notices.

SPHÆROSIDERITE.—(T. Von. Schroeckinger, *Imp. Geol. Instit., Vienna, April* 17, 1877.)

FOUR specimens (*a*, *b*, *c*,) from Felsöbanya, and (*d*) from Kapnik gave the following results, viz:—

	a	*b*	*c*	*d*
Carbonate of Iron	53·07	46·64	62·12	56·84
,, Manganese	44·36	38·07	27·76	39·84
,, Lime	1·15	9·96	7·05	1·29
Water	·76	4·52	2·52	0·67
Alumina	traces	..	traces	..
Silica	traces	..	traces	..
	99·34	99·19	99·45	98·64

The chemical formula is 5 Fe CO_3 + Mn CO_3.

The proportion of manganese thus exceeds, notably, that of Prof. Breithaupt's "oligone spar." The variety *b* appears in very small sphærules (not above one millimeter in diameter), whitish, diaphanous, of concentric texture, densely accumulated on and between distinctly crystallized acicular sulphuret of antimony. The sphærules of variety *c* are rather yellowish brown, are associated with sulphate of baryta, crystallized in the common form ∞ P ∞. Variety *d* appears in botryoidal stalactitic forms, with distinct, partially concentric, grey and yellowish layers, somewhat resembling agate.

T.R.J.

LAZULITE.—(G. Gamper, *Imp. Geol. Instit., Vienna, April* 17*th*, 1877). This mineral, first made known by Widteman (1791), occurs in the Fresnik Ravine near Koieglach, (Upper Styria), both in blocks of quartzite, and as a vein, several inches broad, and

striking N.E. to S.W. through a bed of quartzite, subordinate to clay-slate, which passes locally into talcose slate. The matrix of the lazulite is a greyish white quartz, full of small plates of mica, and soft reddish-brown fragments of slate; the lazulite vein following the line of contact between the slate and quartz. Decomposed portions of lazulite are locally dark-blue, of corroded cellular texture, with cubical impressions, and minute crystals of pyrites, the latter are octohedro-cubical combinations, with the octohedron predominating, or of the cube with the pyritohedron (pentagonal dodecahedron). A rather large and perfect crystal of lazulite shows distinctly the surfaces.—2P.

T.R.J.

A new Sulphate of Manganese.—(T. Von Schroeckinger, *Imp. Geol. Instit., Vienna, April 17th*, 1877.) This sulphate, for which the name "szmikite," in honour of Mr. Szmik, Counsellor of Mines, is proposed, occurs at Felsöbanya (Transylvania), in an amorphous stalactitic form, with botryoidal surface and splintery earthy fracture. The colour of the nodules is whitish; the fracture is reddish-white, passing into a delicate rosy tint in the inner botryoidal portions. This mineral scratches talc and is scratched by gypsum (hardness equals 1·5 of Mohs' scale), average density = 3·15

A comparative analysis gave as result.

	a	*b*
Sulphuric Acid	47·43	47·11
Oxide of Manganese	41·78	41·61
Water	10·92	11·19
	100·13	99·91

This corresponds with the chemical formula $Mn\,SO_4 + H_2O$.

Small fragments, of 1 to 2 centimeters, left for some days in a damp place, get a slight increase in weight; and the rosy tint on the recent surfaces of fracture becomes somewhat more intense The artificial crystals obtained from a solution are very indistinct and triclinal, and lose, when roasted, about 3 per cent. of water. The mine in which szmikite occurred, in rather notable quantities, has been abandoned for many years.

T.R.J.

Zeitschrift für Krystallographie, &c., Fünftes Heft.

THOUGH quantitatively less than in the preceding numbers, the mineralogical matter in the present one is none the less valuable, being represented by two able chemico-mineralogical papers.

In the first, on aphtonite and tedrahedrite, from Gärdsjön, in Wermland, by L. F. Nilson, the author, after referring to the rarity of the sulphantimonites, arsenites, and bismuthites, in Sweden, discusses the constitution of aphtonite. Svanberg gave to it the formula

$$7\,RS,\ Sb_2S_3$$

in which the Cu appeared as CuS, while in other sulphides the generally accepted state is Cu_2S. But the analysis of Svanberg agrees, as the author shows, very exactly with a formula corresponding with that of tetrahedrite, with the exception that the antimony appears as pentasulphide thus:

$$4\,RS,\ Sb_2S_5$$

or more defined

$$2\,(4Cu_2S,\ Sb_2S_5) + \left.\begin{matrix}3\,Zn\,S\\Fe\,S\end{matrix}\right\}\,Sb_2S_5$$

The five careful analyses of the author lead him, however, to a different result, he finds that the mineral in question is a true tetrahedrite, corresponding to the formula,

$$2\,(4\,R_2S,\ Sb_2S_3) + 4\,RS,\ Sb_2S_3$$

differing from Svanberg's therefore, only in the quantity of sulphur.

$$R{=}Cu,\ Ag,\ Zn,\ Fe;\ G{=}4{\cdot}89.$$

The second paper: On the occurrence of astrophyllite, arfvedsonite, and zircon, in El Paso Co., Colorado, has been published, contemporaneously, in the Proc. Acad. Nat. Soc., Philadelphia, 1877, p. 9.

These minerals occur, and are associated, in what appears to be a syenite, in a very similar manner as at Brevig, in Norway.

The analysis shows the astrophyllite to be chemically equivalent with that of Brevig, whilst the optical properties, as described in a supplement by Dr. Bücking, are identical in both and prove the mineral to be clinorhombic. The author describes an interesting colorimetric method of estimating, by means of blowpipe beads, the relative quantities of titanic acid and zirconia (or alumina) in a mixture of the two. 2 milligrams of the mixture to be analysed are dissolved in a bead of microcosmic salt weighing 0·065 grams., and treated in the reducing flame. The colour of this bead is compared with a series of 10 beads of the same weight, enclosed in a sealed tube, each of which contains 2 milligrams of a mixture of TiO_2 and ZrO_2 (or Al_2O_3) in proportions varying by 10 per cent.; by the aid of further intermediate beads, the relative proportions of the two substances can be determined to within $2\frac{1}{2}$ per cent., a result far more accurate than any obtainable by wet methods.

The arfvedsonite shows a somewhat unusual composition, whilst the zircon is remarkable for the rare basal plane, each crystal showing the combination, 111· 110· 001·

Among the correspondence, &c., we find a note by A. v. Lasaulx, on iodobromite from Dernbach, in Nassau. This mineral occurs in small yellow regular octahedrons of the composition, 2 Ag (Cl, Br) + AgI; and abstracts, among others, of the following memoirs:—T. Sterry Hunt, venerite, a new copper ore, it probably belongs to the chlorites; V. Fernandez and S. Navia, silaonite, a new mineral, composition, Bi_3Se; P. Groth, pseudophite, from Markirch in the Vosges. This mineral is a compact variety of penninite. J. Bachmann, on a new mineral locality in Valais: In the Lötschenthal, in the zone of the green slates, are found quartz, calcite, chlorite, orthoclase, desmine, stilbite, and axinite. A. Streng, on chabasite: An elaborate memoir on the chemical, crystallographical, and optical properties of this mineral, and the varieties phakolite, seebachite, herschelite, gmelinite, and levynite, which, according to the author, can no longer be regarded as separate species. He further shows that the supposed skalenohedron $^{13}/_{16}$ R $^{5}/_{4}$ of Phillips and Haidinger is no true crystallographic form, and that the pinnate striations are not due to repeated twinning, but that both appearances are produced by the irregular action of the internal forces during

the growth of the penetration twin, thus resulting in the formation of "vicinal" planes; I. v. Schröckinger, sphaerosiderites from Hungary, rich in manganese. They contain up to 44 per cent. of Mn Co^3; the same szmikite, a new manganese sulphate. Stalactitic, with the composition Mn SO^4 + H^2O, from Felsöbanya. Lastly, we find two abstracts of papers on barium felspar by different authors, and several on the publications of our Mineralogical Society.

The four plates appended to this number refer solely to O. Lehmann's memoir on the growth of crystals.

C. O. T.

Garnets (Ed. S. Dana, *Am. Journ. Science*, Sept. 1877). The trap rocks of Newhaven, Conn, have been carefully examined by Mr. G. Hawes (*Am. Journ.*, March, 1875), and recently discovered at two distinct localities situated a few miles apart.

The rock consists of labradorite, pyroxene, and magnetite, with a little chrysolite, apatite, and calcite.

The garnets at East Rock are *melanite*, at Mill Rock, *topazolite*. The following analyses are given—the first by G. Hawes, the second by E. S. Dana. The crystals of topazolite are rare but very highly modified.

	ROCK.	MELANITE.
Silica	51·78	35·09
Alumina	14·20	trace
Ferric Oxide	3·59	29·15
Ferrous Oxide	8·25	2·49
Manganous Oxide ..	0·44	0·36
Lime	10·70	32·80
Magnesia	7·63	0·24
Soda	2·14	
Potash	0·39	
Phosphoric Anhydride	0·14	
Ignition	0·63	0·35
	99·89	100·48
Sp. Gr.	3·03	3·74

J. H. C.

Meteoric Stones.—By J. Lawrence Smith (*Am. Journ. of Science*, Sept. 1877). This is a description of the meteoric stones which fell at Rochester, Indiana, (Dec. 21, 1876), Warrenton, Missouri (Jan. 3, 1877), and Cynthiana, Kentucky (Jan. 23, 1877), with remarks on previous falls in the same region. Full analyses are given, and the author gives the following as the mineral constitution of the stones, partly from the chemical and partly from a microscopic examination.

	ROCHESTER.	WARRINGTON.	CYNTHIANA.
Olivine Minerals	41·00	76·00	50·00
Bronzite and Pyroxene ..	46·00	18·00	30·00
Nickeliferous Iron	10·00	2·00	6·00
Troilite	3·00	3·50	5.50
Chrome Iron	·15	·50	·50

J. H. C.

Felspars.—Prof. J. Szabo. On a new method of determining the species of felspars contained in rocks (Budapest, 1876). This method is based upon an accurate determination of the degree of fusibility, and, secondly, upon the degree of flame-colouration observed under certain conditions.

J. H. C.

Venerite (*Am. Journ. Science*, Sept., 1877), occurs as a greenish earthy scaly mass with magnetite, at Jones' Mine, Springfield, Mass., its composition according to Mr. G. W. Hawes, after deducting insoluble matter, is

Silica	30·73
Alumina	14·67
Ferric Oxide	5·35
Ferrous Oxide	0·29
Oxide of Copper	17·58
Magnesia	18·55
Water	12·83
	100·00

It appears to belong to the chlorite group

J. H. C.

Sphœrocobaltite (Dr. A. Weisbach, *Jarhbuch für das Berg., &c.*, 1877) occurs in spheroidal forms with roselite at Schneeberg, Saxony. The spheroids are coarsely radiated and the surfaces are made up of minute rhombohedral crystals, colour peach red, H=4, G=4·02—4·13. BB in matrass blackens; sol. with eff. in warm HCl. Winkler's analysis gave

Cobaltous Oxide	58·86
Lime	1·80
Ferric Oxide	3·41
Carbonic Anhydride	34·65
Water	1·22
	99·94

This corresponds pretty well to the formula Co CO_3, if the lime and hydrated oxide of iron be regarded as impurities.

J. H. C.

Coloradoite.—(F. A. Genth, *Am. Journ. of Science*, Nov. 1877). This mineral occurs at several mines in Colorado. H about 3, G about 8·627, iron-black to gray or purplish; lustre metallic, massive, granular or imperfectly columnar. Comp. Hg Te= tellurium 39·02, mercury 60·98=100.

J. H. C.

Magnolite.—*(ibid.)*. Found at the Keystone mine, Colorado, in fine needles or radiating tufts, white silky. Comp. Hg_2TeO_4, produced by the decomposition of coloradorite.

J. H. C.

Ferrotellurite.—*(ibid.)*. Occurs at the Keystone mine, as a crystalline coating on quartz in very delicate tufts or minute prismatic crystals, yellow to greenish-yellow. Comp. probably $FeTeO_4$.

J. H. C.

Sipylite.—(J. W. Mallet, *Am. Journ. Science*, Nov. 1877). This occurs in small quantities with the allanite of Amherst County, Virginia, accompanied by magnetite and zircon. A few imperfect crystalline faces indicate a form not far from yttro-tantalite, samars-

kite, and euxenite. The Sipylite is red-brown to brownish black, occasionally even yellow, streak light cinnamon brown to pale grey; lustre resinous and pseudo-metallic; translucent in thin splinters; H=6; G=4·89. B.B. decrepitates, glows brilliantly, becomes pale greenish yellow and opaque, in very hot flame melts; in closed tube the same reactions, and gives off water containing fluorine; with borax OF, a yellow glass, pale on cooling; in RF a green tint; with micro. a yellowish-green glass, partly soluble in boiling H Cl; the solution when diluted and boiled with tin becomes a fine sapphire blue, boiling concentrated H_2SO_4 decomposes it slowly but completely.

Mr. W. G. Brown obtained the following results on analysis.

Nb_2O_5 .. .. }	48·66
*Ta_2O_5 .. .. }	
WO_3	·16
SnO_2	·08
ZrO_2	2·09
Eb_2O_3 .. .. }	27·94
†Y_2O_3 .. .. }	
Ce_2O_3	1·37
‡La_2O_3	3·92
§Di_2O_3	4·06
UO	3·47
MnO	trace.
FeO	2·04
BeO	·62
MgO	·05
CaO	2·61
Li_2O	trace.
Na_2O	·16
K_2O	·06
F	trace.
H_2O	3·19
	100·48

J. H. C.

* About 2 p.c.
† About 1 p.c.
‡ With a trace of Didymium.
§ With a trace of Ce^2O^3.

Correspondence.

Scientific Club, 7, Savile Row, W., Oct. 8, 1877.

To the Editor of the Mineralogical Magazine.

Sir,

Some years ago I examined some crystals of aragonite for Strontium. Obtaining unweighable traces I tested in the blowpipe flame, and was not a little surprised to find the coloration was green. In the spectroscope I got from the original substance the lines of both barium and strontium. Is this a common experience? The mineral was from near Wookey Hole, Somerset, whence I brought it myself.

MARSHALL HALL.

NOTE.

Mr Readwin will be glad to exchange a few electrum specimens for new minerals or pseudomorphs.

37, Osborne Road, Tuebrook, Liverpool.

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LIST OF ERRATA.

* COUNTING FROM THE BOTTOM OF THE PAGE.

Page	4	Line	3*	for	"manganesium"	Read	manganese.
"	5	"	11	for	"disulphate"	"	bisulphide.
"	15	"	4	for	"requiaed"	"	required.
"	35	"	5	for	"actynolite"	"	actinolite.
"	38	"	7*	for	"actynolite"	"	actinolite.
"	48	"	5*	for	"pharmocosiderite"	"	pharmacosiderite.
"	73	"	3*	for	"prisims"	"	prisms.
"	108	"	21	for	"desicator"	"	desiccator.
"	112	"	10*	for	"phosphorous"	"	phosphorus.
"	131	"	8	for	"twining"	"	twinning.
"	135	"	9	for	"indispensible"	"	indispensable.
"	142	"	12*	for	"Damone"	"	Damour.
"	154	"	4	for	"stealite"	"	steatite.
"	154	"	6	for	"clean fisure"	"	slicken fissure.
"	154	"	11	for	"diseminated"	"	disseminated.
"	155	"	7	for	"Dumbuch"	"	Dumbuck.
"	155	"	8	for	"cuthbin"	"	cathkin.
"	155	"	9	for	"cuthbins"	"	cathkins.
"	155	"	18	for	"cuthbin"	"	cathkin.
"	155	"	24	for	"misroscope"	"	microscope.
"	155	"	31	for	"cuthbin"	"	cathkin.
"	156	"	17	for	"cuthcurt"	"	cathkin.
"	156	"	30	for	"genuinness"	"	genuineness
"	191	"	6*	for	"Ferri"	"	Ferric.
"	216	"	12*	for	"plate VII"	"	plate VIII.
"	217	"	20	for	"plate VII"	"	plate VIII.
"	223	"	16	for	"plate VII"	"	plate VIII.
"	xx	last line		for	"Newhavern"	"	New Haven.
"	xx	"		for	"sience"	"	science.

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